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F16.15

How Much Additive Comes in With the Solution?

Aspect Ratio		Surface to Solution Molecules					Ratio:
2		299	60	155	52		
2.5		365	73	190	63		
3		432	86	224	75		
3.5		498	100	259	86		
4		565	113	293	98		
4.5		631	126	327	109		
5		697	139	362	121		
5.5		764	153	396	132		

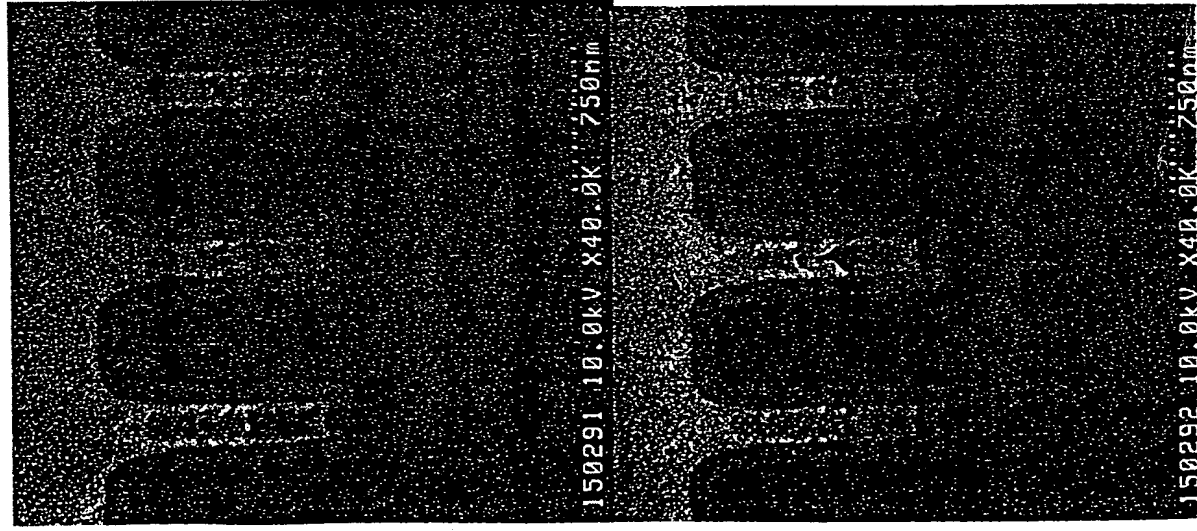
Conditions		Surface to Solution Molecules					Ratio:
ppm		20	100	100	300		
MW		100	100	3000	3000		
Moles/ μm^3		2.0E-19	1.0E-18	3.3E-20	1E-19		
Molec/ μm^3		120460	602300	20077	60230		
Molecules size (nm)		0.5	0.5	1.7	1.7		
Molec/ μm^2		4000000	4000000	346021	346020.8		

Conclusion: At all expected additive condition, there is insufficient material stored in the initial solution within the via to lead to substantial surface absorption in the via.

-There will be an absorption time delay.

Flg. 47

Without Initiation: TI-IMP seed:



- ◆ SEMATECH Backfilled via, Field 3, 0.24 μm x 1.13 μm ,
AR = 4.7

- ◆ Bottom Voids- Yes
- ◆ Side wall Voids - No
- ◆ Top Void- No
- ◆ Center Seam - No
- ◆ Film nucleation-poor
- ◆ Void % = 90%
- ◆ 2 second induction

Barrier/Seed Layer

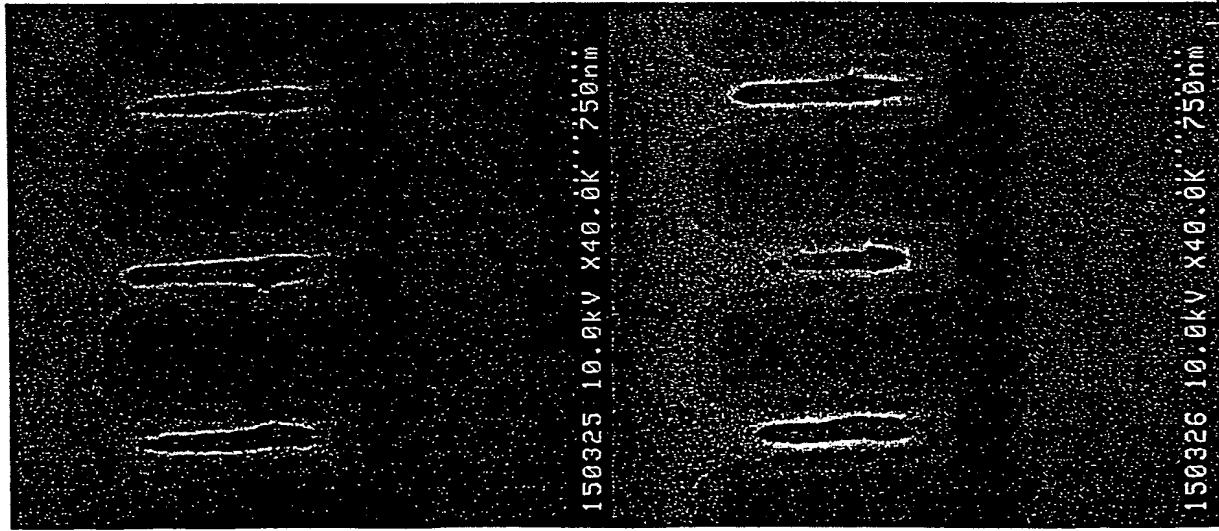
- TI-IMP
- 250Å Ta/1600Å Cu
- Degas Temp. ?
- Sputter etch thickness: ?
- wafer bias: ?

Electroplating

- DC, 7 A
- Bath Conditions
 - [Cu²⁺] = 17.3 g/l H₂SO₄ = 176 g/l
 - [MLO] = 3 ml/l [MD] = 8 ml/l
 - [Cl⁻] = 55 ppm Temp = 22 °C
 - Flow = 8 lpm RPM: 125

F16. 48

With Initiation: TI-IMP seed



- ◆ SEMATECH Backfilled via, Field 3, 0.24 μm x 1.13 μm ,
AR = 4.7
- ◆ Bottom Voids- Yes
- ◆ Side wall Voids - No
- ◆ Top Void- No
- ◆ Center Seam - No
- ◆ Film nucleation-poor
- ◆ Void % = 70%
- ◆ 2 second induction

Barrier/Seed Layer

TI-IMP

-250Å Ta/2200Å Cu

-Degas Temp. ?

-Sputter etch thickness: ?

-wafer bias: ?

Electroplating

-DC, 1 A, 15 sec then 7 A

Bath Conditions

[Cu²⁺] = 17.3 g/l H₂SO₄ = 176 g/l

[MLO] = 3 ml/l [MD] = 8 ml/l

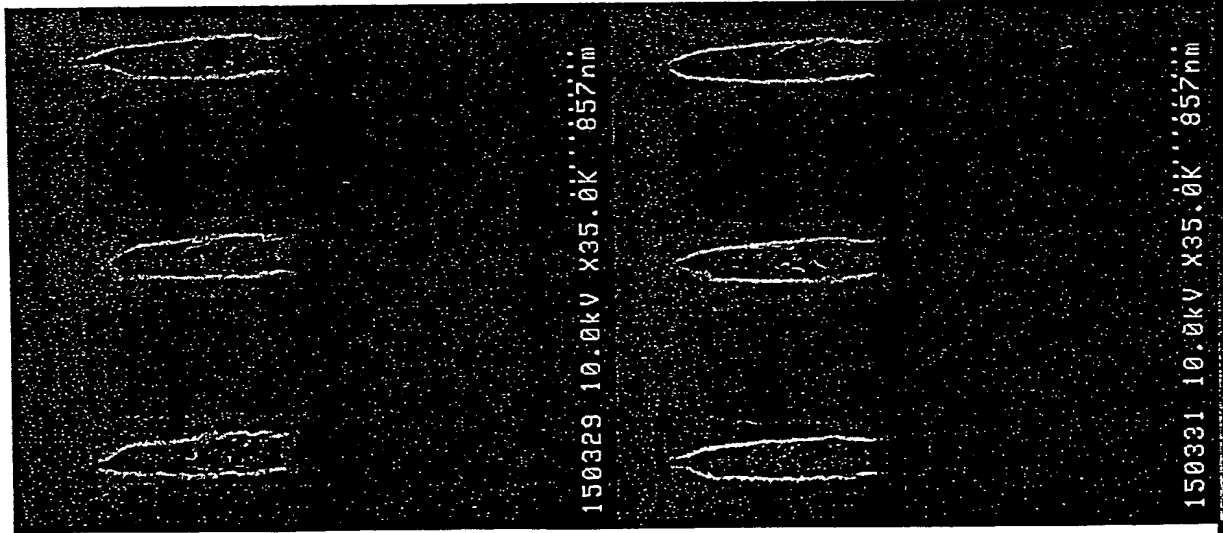
[Cl⁻] = 55 ppm Temp = 22 °C

Flow = 8 lpm RPM: 125

Fig. 49

Without Initiation: Tl-IMP seed

- ◆ SEMATECH Backfilled via , Field 2, 0.29 μm x 1.14 μm ,
AR = 4.0
- ◆ Bottom Voids- Yes
- ◆ Side wall Voids - No
- ◆ Top Void- No
- ◆ Center Seam - No
- ◆ Film nucleation-poor
- ◆ Void % = 90%
- ◆ 2 second induction



Barrier/Seed Layer

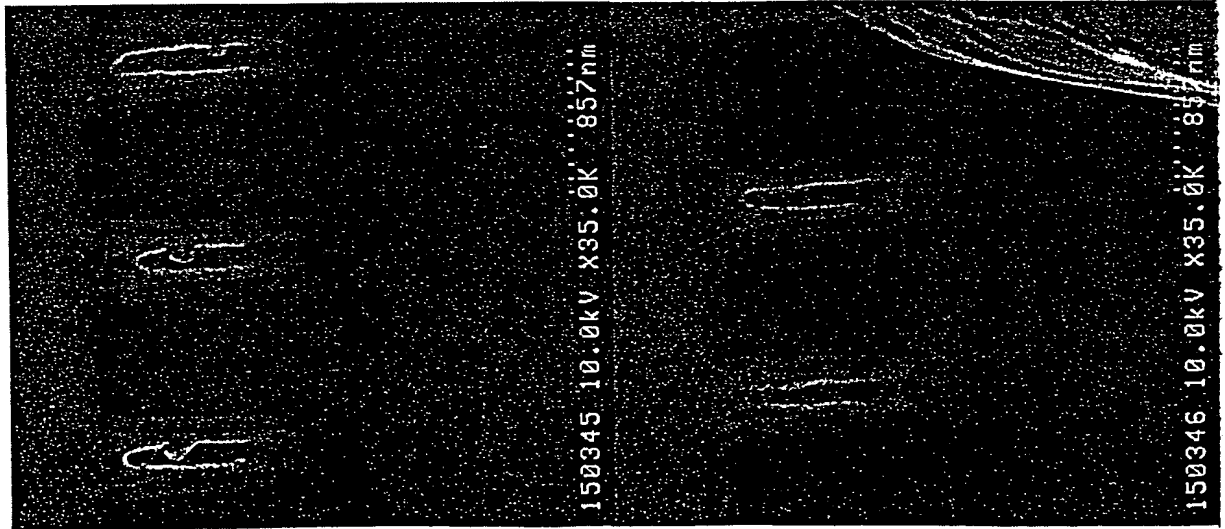
- Tl-IMP
- 250Å Ta/1600Å Cu
- Degas Temp. ?
- Sputter etch thickness: ?
- wafer bias: ?

Electroplating

- DC, 7 A
- Bath Conditions
 - [Cu²⁺] = 17.3 g/l H₂SO₄ = 176 g/l
 - [MLO] = 3 ml/l [MD] = 8 ml/l
 - [Cr] = 55 ppm Temp = 22 °C
 - Flow = 8 lpm RPM: 125

Flg. 50

With Initiation: TI-IMP seed



- ◆ SEMATECH Backfilled via , Field 2, 0.29 μm x 1.14 μm ,
AR = 4.0

- ◆ Bottom Voids- Yes
- ◆ Side wall Voids - No
- ◆ Top Void- No
- ◆ Center Seam - No
- ◆ Film nucleation-poor
- ◆ Void % = 60%
- ◆ 2 second induction

Barrier/Seed Layer

TI-IMP

-250Å Ta/2200Å Cu

-Degas Temp. ?

-Sputter etch thickness: ?

-wafer bias: ?

Electroplating

-DC, 1 A, 15 sec then 7 A

Bath Conditions

[Cu²⁺] = 17.3 g/l H₂SO₄ = 176 g/l

[MLO] = 3 ml/l [MD] = 8 ml/l

[Cr] = 55 ppm Temp = 22 °C

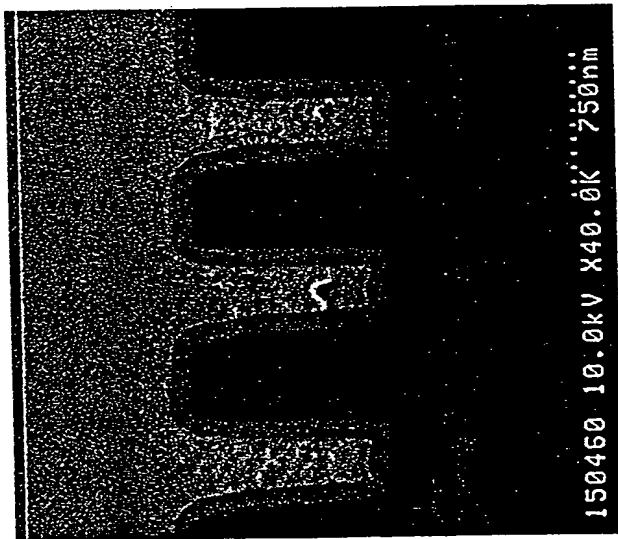
Flow = 8 lpm RPM: 125

File 51

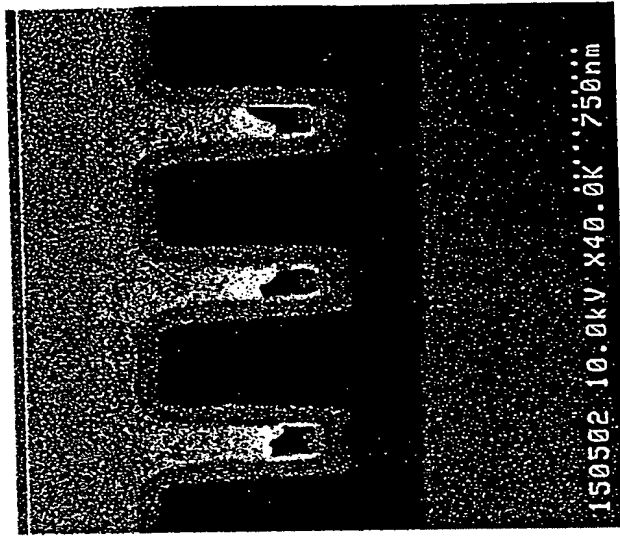
Initiation: Low current, 2 second induction



Field 2, 0.29 μm x 1.14 μm , AR = 4.0



Field 3, 0.24 μm x 1.13 μm , AR = 4.7
•Void % = 1.3 %



Field 4, 0.2 μm x 1.0 μm , AR = 5.0
•Void % = 15.8 %

- ◆ SEMATECH Backfilled via

- ◆ TI-JMP Seed

- ◆ 250Å Ta/1600Å Cu

Electroplating

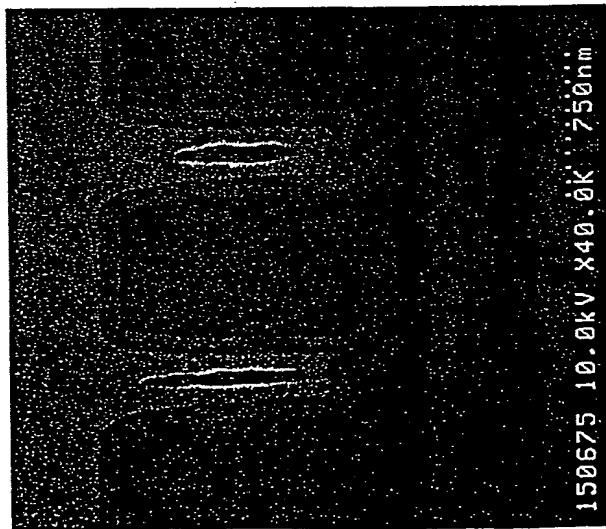
- ◆ Step 1: 1 A for 15 sec
- ◆ Step 2: DC, 7 A

Bath Conditions

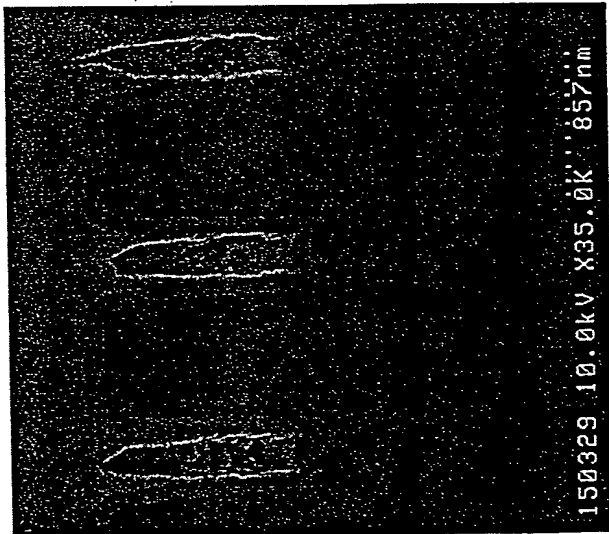
[Cu ²⁺] = 17.3 g/l	H ₂ SO ₄ = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
[Cl ⁻] = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125

Fig. 52

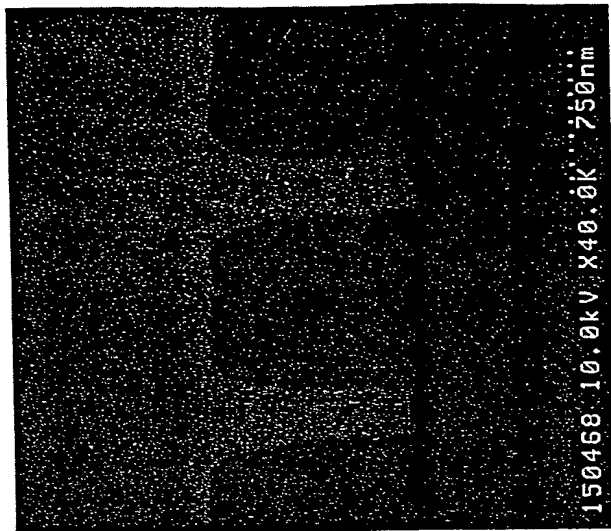
Initiation: Effect of Induction Delay



- ◆ DC, 7 A, 0 sec induction
- ◆ Void % = 16 %



- ◆ DC, 7 A, 2 sec induction
- ◆ Void % = 53 %



- ◆ Step 1: DC 1 A, 15 sec, 2 sec induction
- ◆ Step 2: DC, 7 A
- ◆ Void % = 53 %

- ◆ SEMATECH Backfilled via

- ◆ TI-JMP Seed

- ◆ 250Å Ta/1600Å Cu

Field 2, 0.29 μm x 1.14 μm, AR = 4.0

Bath Conditions

[Cu ²⁺] = 17.3 g/l	H ₂ SO ₄ = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
[Cl ⁻] = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125